

February 1991

## Articles

Editorial .....	2
-----------------	---

## CSChE/SCGCh 25th Anniversary Thematic Section: Systems and Control

Introduction and Overview • William R. Cluett and Thomas J. Harris .....	3
--	---

## Process Analysis and Design

Process Control: An Overview and Personal Perspective • D. Grant Fisher .....	5
The Error-in-Variables Model Applied to Parameter Estimation When the Error Covariance Matrix is Unknown • Scott E. Keeler and Park M. Reilly .....	27
Multivariate Statistical Monitoring of Process Operating Performance • James V. Kresta, John F. MacGregor and Thomas E. Marlin .....	35
Statistical Process Control Procedures for Correlated Observations • Thomas J. Harris and William H. Ross	48
A Method for Flexibility Analysis of Continuous Processing Plants • D. C. H. Chien, P. L. Douglas and A. Penlidis .....	58
An Expert System for Identifying Separation Processes • Mahesh K. Garg, Peter L. Douglas and James G. Linders	67
The Development of a Deep Knowledge Diagnostic Expert System Using Fault Tree Analysis Information • M. S. Adamson and P. R. Roberge .....	76
Le raisonnement qualitatif-quantitatif de QOSIM • Mario Têtreault, Bernard Marcos et Jean Lapointe .....	81

## Process Control and Optimization

Recursive Least Squares Based Estimation Schemes for Self-Tuning Control • Sirish L. Shah and William R. Cluett .....	89
Analysis and Tuning of Adaptive Generalized Predictive Control • Andrew R. McIntosh, Sirish L. Shah and D. Grant Fisher .....	97
Multi-Input Adaptive-Predictive Control of Kamyrt Digester Chip Level • B. J. Allison, G. A. Dumont and L. H. Novak	111
Long Range Predictive Control of a Polymerization Reactor • M. P. Inglis, W. R. Cluett and A. Penlidis	120
Predictive Control of a Circulating Fluidized Bed Combustor • S. Venugopal, Y. P. Gupta and P. Basu .....	130
Nonlinear Predictive Control Using Multi-rate Sampling • B. Wayne Bequette .....	136
Effect of the Choice of Final Time in Optimal Control of Nonlinear Systems • Rein Luus .....	144
Control Policies for an Industrial Acetylene Hydrogenation Reactor • Michael W. Brown, Alexander Penlidis and Gerald R. Sullivan .....	152
Feedback Control of Crystal Size Distribution in a Continuous Cooling Crystallizer • S. Rohani and K. Paine	165

## Regular Articles

An Improved Two Layer Model for Horizontal Slurry Pipeline Flow • R. G. Gillies, C. A. Shook and K. C. Wilson	173
---	-----

Friction Factor for Gas-Non-Newtonian Liquid Flow in Horizontal Bends • S. K. Das, M. N. Biswas and A. K. Mitra .....	179
A Two-Fluid Model for Non-Equilibrium Two-Phase Critical Discharge • C. F. Schwellnus and M. Shoukri	188
Laminar Flow of a Liquid Rivulet Down a Vertical Solid Surface • Andrzej Doniec .....	198
A Study of the Deposition of Silt onto the Surface of Type 304 Stainless Steel • C. W. Turner and D. H. Lister	203
Hydrodynamics of a Vibrating Perforated Plate Extraction Column • N. V. Rama Rao, S. Vijayan and M. H. I. Baird .....	212
Types of Dispersion in Agitated Liquid-Liquid Systems • Satoru Kato, Eiichi Nakayama and Juniro Kawasaki	222
Gas Liquid Contacting in Reciprocating Plate Columns: I. Hydrodynamics • H. G. Gomaa, J. Landau and A. M. Al Taweel .....	228
Extrudate Swell of Newtonian Liquids from Rectangular Dies • M. N. Esmail .....	240
Production of Uniform Drops of Viscous Liquids Using a Coaxial Airstream • John W. Blynsniuk and Michael V. Sefon .....	245
Motion of Pulp Fibre Suspensions in Rotary Devices • C. P. J. Bennington, R. J. Kerekes and J. R. Grace .....	251
Effects of Wettability and Pore Geometry on Mobilization of Oil and Gas in Physical Models and Application to Water-Alternating-Gas (WAG) Injections • V. W. Tang Kong and N. C. Wardlaw .....	259
Impingement Heat Transfer Under a Confined Slot Jet. Part I: Effect of Surface Throughflow • S. Polat, A. S. Mujumdar and W. J. M. Douglas .....	266
Impingement Heat Transfer Under a Confined Slot Jet. Part II: Effects of Surface Motion and Throughflow • S. Polat, A. S. Mujumdar and W. J. M. Douglas .....	274
Experimental Studies on Heat Transfer with Phase Change on Diverging-Converging Surfaces • T. K. Chakravarty, C. M. Narayanan and B. C. Bhattacharyya	281
Temperature Field Within a Devolatilizing Coal Particle • Jerzy Tomczek and Jan Kowol .....	286
Mass Transfer in the Entrance Region for Axial and Swirling Annular Flow • M. S. de Sa, L. W. Shemilt and I. V. Soegiarto .....	294
Liquid-Liquid Extraction in a Reciprocating Screen Plate Column • B. H. Chen and C. H. Liu .....	300
Salting Out Crystallization of Sodium Sulfate • George Mina-Mankarios and Kenneth L. Pinder .....	308
On the Use of Approximate Velocity Profiles for Modeling Multiphase Reactors • William H. Zimmerman and Uragomir B. Bukur .....	325
Reactor Design and Operation for Gas-Phase Ethylene Polymerization Using Ziegler-Natta Catalysts • David T. Lynch and Sieghard E. Wanke .....	332
Kinetics of the Allylation of Phenoxide by Polyethylene Glycol in a Two-Phase Reaction • Maw-Ling Wang and Kong-Rong Chang .....	340
Hydrogenation of Carbon Dioxide by Hybrid Catalysts, Direct Synthesis of Aromatics from Carbon Dioxide and Hydrogen • Chi-Kung Kuei and Min-Dar Lee .....	347
Deactivation of Cracking Catalyst in Short Contact Time Reactors: Alternative Models • D. Kraemer, M. Larocca and H. I. de Lasa .....	355
Mathematical Modelling of Protein Diffusion in Microcapsules: A Comparison With Experimental Results • W. Y. Kwok, C. Kiparissides, P. Yuet, T. J. Harris and M. F. A. Goosen .....	361
The Effect of Dehydration Conditions on the Adsorption and Diffusion of Propane and Nitrogen in Linde 5A Zeolite • H. O. Tezel and D. M. Ruthven .....	371
Simplified Analytical Prediction of Distillation Column Startup Time at Total Reflux • Oscar A. Iribarren and Omar J. Chiotti .....	377

February 1991

## Articles

Editorial .....	2
-----------------	---

## CSChE/SCGCh 25th Anniversary Thematic Section: Systems and Control

Introduction and Overview • William R. Cluett and Thomas J. Harris .....	3
--	---

## Process Analysis and Design

Process Control: An Overview and Personal Perspective • D. Grant Fisher .....	5
The Error-in-Variables Model Applied to Parameter Estimation When the Error Covariance Matrix is Unknown • Scott E. Keeler and Park M. Reilly .....	27
Multivariate Statistical Monitoring of Process Operating Performance • James V. Kresta, John F. MacGregor and Thomas E. Marlin .....	35
Statistical Process Control Procedures for Correlated Observations • Thomas J. Harris and William H. Ross	48
A Method for Flexibility Analysis of Continuous Processing Plants • D. C. H. Chien, P. L. Douglas and A. Penlidis .....	58
An Expert System for Identifying Separation Processes • Mahesh K. Garg, Peter L. Douglas and James G. Linders	67
The Development of a Deep Knowledge Diagnostic Expert System Using Fault Tree Analysis Information • M. S. Adamson and P. R. Roberge .....	76
Le raisonnement qualitatif-quantitatif de QOSIM • Mario Têtreault, Bernard Marcos et Jean Lapointe .....	81

## Process Control and Optimization

Recursive Least Squares Based Estimation Schemes for Self-Tuning Control • Sirish L. Shah and William R. Cluett .....	89
Analysis and Tuning of Adaptive Generalized Predictive Control • Andrew R. McIntosh, Sirish L. Shah and D. Grant Fisher .....	97
Multi-Input Adaptive-Predictive Control of Kamyrt Digester Chip Level • B. J. Allison, G. A. Dumont and L. H. Novak	111
Long Range Predictive Control of a Polymerization Reactor • M. P. Inglis, W. R. Cluett and A. Penlidis	120
Predictive Control of a Circulating Fluidized Bed Combustor • S. Venugopal, Y. P. Gupta and P. Basu .....	130
Nonlinear Predictive Control Using Multi-rate Sampling • B. Wayne Bequette .....	136
Effect of the Choice of Final Time in Optimal Control of Nonlinear Systems • Rein Luus .....	144
Control Policies for an Industrial Acetylene Hydrogenation Reactor • Michael W. Brown, Alexander Penlidis and Gerald R. Sullivan .....	152
Feedback Control of Crystal Size Distribution in a Continuous Cooling Crystallizer • S. Rohani and K. Paine	165

## Regular Articles

An Improved Two Layer Model for Horizontal Slurry Pipeline Flow • R. G. Gillies, C. A. Shook and K. C. Wilson	173
---	-----

Friction Factor for Gas-Non-Newtonian Liquid Flow in Horizontal Bends • S. K. Das, M. N. Biswas and A. K. Mitra .....	179
A Two-Fluid Model for Non-Equilibrium Two-Phase Critical Discharge • C. F. Schwellnus and M. Shoukri	188
Laminar Flow of a Liquid Rivulet Down a Vertical Solid Surface • Andrzej Doniec .....	198
A Study of the Deposition of Silt onto the Surface of Type 304 Stainless Steel • C. W. Turner and D. H. Lister	203
Hydrodynamics of a Vibrating Perforated Plate Extraction Column • N. V. Rama Rao, S. Vijayan and M. H. I. Baird .....	212
Types of Dispersion in Agitated Liquid-Liquid Systems • Satoru Kato, Eiichi Nakayama and Juniro Kawasaki	222
Gas Liquid Contacting in Reciprocating Plate Columns: I. Hydrodynamics • H. G. Gomaa, J. Landau and A. M. Al Taweel .....	228
Extrudate Swell of Newtonian Liquids from Rectangular Dies • M. N. Esmail .....	240
Production of Uniform Drops of Viscous Liquids Using a Coaxial Airstream • John W. Blysnik and Michael V. Sefon .....	245
Motion of Pulp Fibre Suspensions in Rotary Devices • C. P. J. Bennington, R. J. Kerekes and J. R. Grace .....	251
Effects of Wettability and Pore Geometry on Mobilization of Oil and Gas in Physical Models and Application to Water-Alternating-Gas (WAG) Injections • V. W. Tang Kong and N. C. Wardlaw .....	259
Impingement Heat Transfer Under a Confined Slot Jet. Part I: Effect of Surface Throughflow • S. Polat, A. S. Mujumdar and W. J. M. Douglas .....	266
Impingement Heat Transfer Under a Confined Slot Jet. Part II: Effects of Surface Motion and Throughflow • S. Polat, A. S. Mujumdar and W. J. M. Douglas .....	274
Experimental Studies on Heat Transfer with Phase Change on Diverging-Converging Surfaces • T. K. Chakravarty, C. M. Narayanan and B. C. Bhattacharyya	281
Temperature Field Within a Devolatilizing Coal Particle • Jerzy Tomczek and Jan Kowol .....	286
Mass Transfer in the Entrance Region for Axial and Swirling Annular Flow • M. S. de Sa, L. W. Shemilt and I. V. Soegiarto .....	294
Liquid-Liquid Extraction in a Reciprocating Screen Plate Column • B. H. Chen and C. H. Liu .....	300
Salting Out Crystallization of Sodium Sulfate • George Mina-Mankarios and Kenneth L. Pinder .....	308
On the Use of Approximate Velocity Profiles for Modeling Multiphase Reactors • William H. Zimmerman and Uragomir B. Bukur .....	325
Reactor Design and Operation for Gas-Phase Ethylene Polymerization Using Ziegler-Natta Catalysts • David T. Lynch and Sieghard E. Wanke .....	332
Kinetics of the Allylation of Phenoxide by Polyethylene Glycol in a Two-Phase Reaction • Maw-Ling Wang and Kong-Rong Chang .....	340
Hydrogenation of Carbon Dioxide by Hybrid Catalysts, Direct Synthesis of Aromatics from Carbon Dioxide and Hydrogen • Chi-Kung Kuei and Min-Dar Lee .....	347
Deactivation of Cracking Catalyst in Short Contact Time Reactors: Alternative Models • D. Kraemer, M. Larocca and H. I. de Lasa .....	355
Mathematical Modelling of Protein Diffusion in Microcapsules: A Comparison With Experimental Results • W. Y. Kwok, C. Kiparissides, P. Yuet, T. J. Harris and M. F. A. Goosen .....	361
The Effect of Dehydration Conditions on the Adsorption and Diffusion of Propane and Nitrogen in Linde 5A Zeolite • H. O. Tezel and D. M. Ruthven .....	371
Simplified Analytical Prediction of Distillation Column Startup Time at Total Reflux • Oscar A. Iribarren and Omar J. Chiotti .....	377

## Notes

Hydrodynamic Entrance Lengths of Non-Newtonian Laminar Falling Films • Ruokang Li	383
Prediction of the Maximum Spoutable Bed Height in Spout-Fluid Beds • Ž. B. Grbavčić, D. V. Vuković, Dž. E. Hadžismajlović, R. V. Garić and H. Littman	386
Effect of Solid Particles on Gas Hold-Up in Bubble Columns • M. Jamialahmadi and H. Müller-Steinhagen	390
Contents Page from Chemical Engineering Research and Design	393
Isobaric Vapor-Liquid Equilibria for Binary Systems Composed of Methyl Butanoate with Ethanol and with Propan-1-ol at 114.66 and 127.99 kPa • Juan Ortega and Pedro Susial	394
Instructions to Authors	400
Book Reviews	IBC

April 1991

## CSCHe/SCGCh 25th Anniversary Thematic Section: Biotechnology

Introduction and Overview • Leo A. Behie and Paul P. Matteau	401
<b>Animal/Mammalian Cell Fermentations</b>	
An Industrial Cell Biologist's Wish List • Sally S. Seaver	403
Animal Cell Bioreactors — Recent Advances and Challenges to Scale-Up • Wei-Shou Hu and Madhusudan V. Peshwa	409
Nutrient and Metabolite Gradients in Mammalian Cell Hollow Fiber Bioreactors • J. M. Piret, D. A. Devens and C. L. Cooney	421
The Effect of Specific Growth Rate and Death Rate on Monoclonal Antibody Production in Hybridoma Chemostat Cultures • Theodor I. Linardos, Nicolas Kalogerakis, Leo A. Behie and Louis R. Lamontagne	429
Immobilization of Hybridoma Cells in Chitosan Alginate Beads • S. Overgaard, J. M. Scharer, M. Moo-Young and N. C. Bols	439
Evaluation of a Hollow Fiber Oxygenator for Use in Bubble-Free Mammalian Cell Bioreactors • Nicolas Kalogerakis and Leo A. Behie	444
Insect Cell Cultivation Techniques for the Production of High-Valued Products • Mattheus F. A. Goosen	450
Growth Characteristics of a <i>Bombyx mori</i> Insect Cell Line in Stationary and Suspension Cultures • Dimitrios A. Stavroulakis, Nicolas Kalogerakis, Leo A. Behie and Kostas Iatrou	457
Hydrodynamics in Rectangular Air-lift Reactors: Scale-up and the Influence of Gas-Liquid Separator Design • Marc Siegel and Jose C. Merchuk	465
Characterizing Bubbles in Bioreactors Using Light or Ultrasound Probes: Data Analysis by Classical Means and by Neural Networks • G. Bugmann, J. B. Lister and U. von Stockar	474
Adaptive Neural Models for On-line Prediction in Fermentation • Vincent Van Breusegem, Jules Thibault and Arlette Chéry	481

## Microbial Fermentations

The Economics of Ethanol Production by Extractive Fermentation • Andrew J. Daugulis, Darryl B. Axford and P. James McLellan	488
---	-----

The Prediction of Transport Parameters in Filamentous Fermentation Broths Based on Results Obtained in Pseudoplastic Polymer Solutions • D. Grant Allen and Campbell W. Robinson	498
Gas-Liquid Mass Transfer in the Bubble Column with Viscoelastic Liquid • I.-S. Suh, A. Schumpe, W.-D. Deckwer and W.-M. Kulicke	506
Experimental Simulation of Large-Scale Bioreactor Environments Using a Monte Carlo Method • Pradyumna K. Namdev, Pallavur K. Yegneswaran, B. G. Thompson and Murray R. Gray	513
NADH Fluorescence in a Fed Batch Fermentation by <i>C. acetobutylicum</i> • A. K. Srivastava and B. Volesky	520
Carrier Influence in Anaerobic Biofilm Fluidized Beds for Treating Vapour Condensate from the Sulphite Cellulose Process • S. Petrozzi, I. J. Dunn, E. Heinzle and O. M. Kut	527
Analysis of Final Settling Tank in Relation to Control of Metal Inhibition in the Activated Sludge Process • R. D. Tyagi, D. Couillard and F. T. Tran	534
Approximate Analytical Solutions for a Biofilm Reactor Model with Monod Kinetics and Product Inhibition • G. V. Bhaskar and S. M. Rao Bhamidimarri	544
Enzyme Mass Transfer Coefficient in Aqueous Two Phase System Using a Packed Extraction Column • T. A. Patil, K. Rostami Jafarabad, S. B. Sawant and J. B. Joshi	548

## Regular Articles

Linear Displacement of a Wetting Fluid by an Immiscible Non-wetting Fluid in a Porous Medium: A Predictive Algorithm • D. G. Kiriakidis, E. Mitsoulis and G. H. Neale	557
Suspension Codeposition in Electrowinning Cells: The Role of Hydrodynamics • J. W. Graydon and D. W. Kirk	564
Electrochemical Kinetic Parameters for the Cathodic Deposition of Copper from Dilute Aqueous Acid Sulfate Solutions • J. T. Hinatsu and F. R. Foulkes	571
Adaptive Control of Hydrodynamic Holdup in a Karr Extraction Column • M. C. Camurdan, P. A. Taylor and M. H. I. Baird	578
An Application of a Cascaded Self Tuning Regulator to a Karr Solvent Extraction Column • M. C. Camurdan, P. A. Taylor and M. H. I. Baird	588
A Mathematical Model of a Spouted Bed Gasifier • C. J. Lim, J. P. Lucas, M. Haji-Sulaiman and A. P. Watkinson	596
Book Review	607
Letter to the Editor	608
Contents Page from Chemical Engineering Research and Design	608

June 1991

## CSCHe/SCGCh 25th Anniversary Thematic Section: Polymer Reaction Engineering

Introduction and Overview • A. Penlidis and T. W. Hoffman	609
Kinetics of Free Radical Modification of Polyolefins in Extruders — Chain Scission, Crosslinking and Grafting • A. E. Hamielec, P. E. Gloor and S. Zhu	611
Polymer Alloys and Blends: Recent Advances • Basil D. Favis	619
Modelling of Addition Polymerization Processes — Free Radical, Ionic, Group Transfer, and Ziegler-Natta Kinetics • W. Harmon Ray	626
Bulk Polymerization in Tubular Reactors I. Experimental Observations on Fouling • M. F. Cunningham, K. F. O'Driscoll and H. K. Mahabadi	630

Emulsification of a Viscous Monomer Mix: Particle Size and Size Distribution • Charles E. Chaffey, Suzanne Tasaloti and Anthony J. Paine.....	639
State Estimation For Continuous Emulsion Polymerization • Louise Gagnon and J. F. MacGregor.....	648
The Influence of Aluminum Alkyls on the Polymerization of Ethylene with $\text{SiO}_2/\text{MgCl}_2$ -Supported $\text{TiCl}_4$ Catalysts • David T. Lynch, M. Olukayode Jejelowo and Sieghard E. Wanke.....	657
Morphological Influences in the Gas Phase Polymerization of Ethylene by Silica Supported Chromium Oxide Catalysts • Steven W. Webb, E. L. Weist, M. G. Chiovetta, R. L. Laurence and W. C. Conner.....	665
Modélisation de la copolymérisation éthylène $\alpha$ -oléfine par catalyse Ziegler-Natta • Pascal Lorenzini, Pascale Bertrand et Jacques Villiermaux.....	682

## Regular Articles

Hydrodynamics of Disturbed Flow and Erosion-Corrosion. Part I — Single-phase Flow Study • S. Nešić and J. Postlethwaite.....	698
Hydrodynamics of Disturbed Flow and Erosion-Corrosion. Part II — Two-phase Flow Study • S. Nešić and J. Postlethwaite.....	704
Hydrodynamics and Mass Transfer in an Upward Venturi/Bubble Column Combination • L. X. Huynh, C. L. Briens, J. F. Large, A. Catros, J. R. Bernard and M. A. Bergougnou.....	711
A Numerical Solution of the Wavy Motion on a Falling Liquid Film • Ru Yang and Byard D. Wood.....	723
An Experimental Study of Motion of Cylinders in Newtonian Fluids: Wall Effects and Drag Coefficient • A. Unnikrishnan and R. P. Chhabra.....	729
Transient Heating and Cooling of Cocurrent Three-Phase Fluidized Beds • B. P. A. Grandjean, P. J. Carreau and J. Paris.....	736
Pool Boiling Heat Transfer to Saturated Water and Refrigerant 113 • M. Jamialahmadi, R. Blöchl and H. Müller-Steinhagen.....	746
Heat Transfer from Finned Surfaces with a Uniform Fouling Deposit • J. Middis and H. M. Müller-Steinhagen.....	755
Control of Mass Transfer and Hydrodynamic Holdup in a Karr Solvent Extraction Column • M. C. Camurdan, P. A. Taylor and M. H. I. Baird.....	761
Kinetic Model of Parallel Self-Poisoning in the Catalytic Hydrogenolysis of Ethane on Single-Type Surface Sites • Janos Szamosi and Sandor Kristyán.....	772
Procédé de Solubilisation Biologique des Métaux dans les Boues Anaérobies d'Épuration: Filtrabilité, Neutralisation et Teneurs en N et P des Boues Traitées • D. Couillard et G. Mercier.....	779
Improving Prediction of Salt Effect on VLE of Isopropyl Alcohol- $\text{H}_2\text{O}$ -Salt and Methanol- $\text{H}_2\text{O}$ -Salt Systems with Preferential Association • Liang-Sun Lee, Yung-Zin Tsao and Barry L. M. Yang.....	788
Isobaric Vapor Liquid Equilibrium in Binary Mixtures of $\alpha$ -Pinene, Limonene and 1, 8-Cineole • Fátima Farelo, Filomena Santos and Lurdes Serrano.....	794
Equilibrium Conditions for Methane Hydrate Formation in Aqueous Mixed Electrolyte Solutions • P. D. Dholabhai, P. Englezos, N. Kalogerakis and P. R. Bishnoi.....	800

## Notes

Determination of Reaction Models from Experimental Measurements • Mitsunori Makino and P. L. Silveston.....	806
Contents Page from Chemical Engineering Research and Design.....	810
$\text{CO}_2$ Gasification Kinetics of Two Alberta Coal Chars • G. Kovacic, A. Chambers and B. Özüm.....	811

Book Review.....	816
------------------	-----

August 1991

## CSCHE/SCGCh 25th Anniversary Thematic Section: Advanced Energy Systems and Fuel Processing

Introduction and Overview • Kelly V. Thambimuthu and Esteban Chornet.....	817
Heavy Oil Recovery and Processing	
Horizontal Wells and Steam-Assisted Gravity Drainage • R. M. Butler.....	819
Application of the Rotating Disk Method to the Study of Bitumen Dissolution into Organic Solvents • R. K. Ulrich, M. K. Koppaiah and V. K. Majumdar.....	825
The Relationship Between Chemical Structure and Reactivity of Alberta Bitumens and Heavy Oils • M. R. Gray, P. Jokuty, H. Yeniova, L. Nazarewycz, S. E. Wanke, U. Achia, A. Krzywicki, E. C. Sanford and O. K. Y. Sy.....	833
Desulfurization of Benzothiophene with Molybdenum Naphthenate. Application of Statistical Analysis to Evaluate the Role of Donor Solvent • F. T. T. Ng and G. R. Walker.....	844

## Combustion, Gasification and Pyrolysis of Coals

Circulating Fluidized Bed Combustion of a High-Sulphur Eastern Canadian Coal • C. M. H. Brereton, C. J. Lim, R. Legros, J. Zhao, H. Li and J. R. Grace.....	852
Modelling of Circulating Fluidized Bed Combustion of a Char • Umberto Arena, Alberto Malandrino and Leopoldo Massimilla.....	860
Distribution of Volatile Sulphur Containing Products During Fixed Bed Pyrolysis and Gasification of Coals • Edward Furinsky, Allan D. Palmer and Meng Cheng.....	869
Étude d'un procédé de pyrolyse rapide du charbon dans un réacteur cyclone • J. L. Houzelot, P. Hilaire, A. Lebrun-Cabon, J. Villiermaux, R. Bertau et D. Isler.....	876

## Hydrocarbons from Natural or Synthesis Gas

The Effect of $\text{Nb}_2\text{O}_5$ and $\text{ZrO}_2$ Additions on the Behaviour of $\text{Li/MgO}$ and $\text{Li/Na/MgO}$ Catalysts for the Oxidative Coupling of Methane • D. J. McNamara, S. J. Korf, K. Seshan, J. G. van Ommen and J. R. H. Ross.....	883
Oxidative Coupling of Methane in a Bubbling Fluidized Bed Reactor • R. Andorf, L. Mleczko, D. Schweer and M. Baerns.....	891
Kinetic Modelling of the Catalytic Conversion of Synthesis Gas into Liquid Hydrocarbons • F. Simard, A. Mahay, G. Jean and H. de Lasa.....	898

## Biomass Pyrolysis

Modelling of the Pyrolysis of Biomass Particles. Studies on Kinetics, Thermal and Heat Transfer Effects • C. A. Koufopoulos, N. Papayannakos, G. Maschio and A. Lucchesi.....	907
---	-----

## Regular Articles

Mechanism, Onset and Intensity of Surface Aeration in Geometrically-Similar, Sparged, Agitated Vessels • V. B. Veljković, K. M. Bicok, D. M. Simonović.....	916
An Inverted Cup Reciprocating Plate for Gas Absorption • M. H. I. Baird and N. V. Rama Rao.....	927
La décomposition thermique du <i>n</i> -decane en présence de vapeur d'eau vers 720°C • F. Billaud, K. Elyahyaoui et F. Baronnet.....	933
Thermodynamic Analysis of the Thermochemical Decomposition of $\text{H}_2\text{S}$ in the Presence of Iron Sulphide • Dimitrios Berk, Robert A. Heidemann, William Y. Svrcek and Leo A. Behie.....	944



Kinetic Studies of the Pyrolysis of Sewage Sludge by TGA and Comparison with Fluidized Beds • Ralf DümpeImann, Werner Richarz and Marc R. Stambach	953
An Analysis of Solid Phase Formation in a Liquid Via Image Processing • Z. H. Gu and T. Z. Fahidy	964
Behaviour of Absorption/Stripping Columns for the CO <sub>2</sub> - MEA System: Modelling and Experiments • Germán P. Escobillana, Jorge A. Saez, José R. Pérez-Correa, Heinz J. Neuburg and Lester S. Kershenbaum	969
Accelerated Successive Substitution Schemes for Bubble-Point and Dew-Point Calculations • Ding-Yu Peng	978
Correlation and Prediction of the Viscosity of Defined and Undefined Hydrocarbon Liquids • Juliet McClatchey	986
A New Four-Parameter Cubic Equation of State for Fluids • Dong-Syau Jan and Fuan-Nan Tsai	992
On-Line Multivariable Adaptive Control of a Binary Distillation Column • M. T. Tham, F. Vagi, A. J. Morris and R. K. Wood	997

## Notes

Elucidation of Mean Voidage in Packed Beds • E. A. Foumeny, H. A. Moallemi, C. McGreavy and J. A. A. Castro	1010
Trickle-Bed Reactors: Tracer Study of Liquid Holdup and Wetting Efficiency at High Temperature and Pressure • Z. E. Ring and R. W. Missen	1016
Effect of Sulfite on Reduction Kinetics of Fe(III)NTA Chelate • E. Sada, H. Kumazawa and T. T. Suchecki	1021
Contents Page from Chemical Engineering Research and Design	1024

October 1991

## CSCHE/SCGCh 25th Anniversary Thematic Section: Reactor Engineering and Catalysis

Introduction and Overview • Serge Kaliaguine and Robert R. Hudgins	1025
--	------

## Catalysis and Catalytic Processes

Direct Catalytic Conversion of Methane • Michel G. Poirier, Alan R. Sanger and Kevin J. Smith	1027
Catalytic Palladium-based Membrane Reactors: A Review • J. Shu, B. P. A. Grandjean, A. Van Neste and S. Kaliaguine	1036
A Fluidized Bed Membrane Reactor for the Steam Reforming of Methane • A. M. Adris, S. S. E. H. Elnashaie and R. Hughes	1061
Catalytic Upgrading of Biomass-Derived Oils to Transportation Fuels and Chemicals • R. K. Sharma and N. N. Bakhshi	1071
Upgrading of Tall Oil to Fuels and Chemicals Over HZSM-5 Catalyst Using Various Diluents • R. K. Sharma and N. N. Bakhshi	1082
Kinetics of Aromatics Hydrogenation of Bitumen-Derived Gas Oils • Sok M. Yui and Emerson C. Sanford	1087
Vapor Phase Reaction of Cyclohexanone Oxime Over Boria Modified HZSM-5 Zeolites • Takeshige Takahashi, Kazuhiko Ueno and Takami Kai	1096
Catalyst Decay in the Presence of Chain Processes in Catalytic Cracking • N. M. Rice and B. W. Wojciechowski	1100

## Reaction and Reactor Engineering

Catalytic Oxidation of Carbon Monoxide Under Periodic Operation • P. L. Silveston	1106
Selectivity Improvement Using Alternate Flushing and Reactant Cycle Steps • X.-S. Lang, P. L. Silveston and R. R. Hudgins	1121

Influence of Particle Size Distribution on the Performance of Fluidized Bed Reactors • J. R. Grace and G. Sun	1126
Interaction Between Micro- and Macro-mixing During Reactions in Agitated Tanks • S. Thoma, V. V. Ranade and J. R. Bourne	1135
Boundary Layer Model for Char Combustion and Gasification • B. Özüm, A. Chambers, G. Kovacic and M. Oğuztörelı	1142
Regeneration of Spent Activated Carbon by Wet Air Oxidation • V. D. Mundale, H. S. Joglekar, Abul Kalam and J. B. Joshi	1149
Kinetics of Desulfurization of Hydrogen Sulfide Using Metallic Copper as a Desulfurizer • Qiyuan Chen, Lili Li and Loren G. Hepler	1160

## Regular Articles

Dispersion and Slip Effects in Hydraulic Hoisting of Solids • J. Evans and C. A. Shook	1166
The Effect of Electric Field on Droplet Formation and Motion in a Viscous Liquid • W. He, M. H. I. Baird and J. S. Chang	1174
Constrained Chemical Equilibrium and Incompletely Specified Elemental Abundance Data • G. W. Norval, M. J. Phillips, R. W. Missen and W. R. Smith	1184
A High Pressure Solubility Apparatus for Gases of High Solubility • W. Hayduk, H. Asatani and Y. Miyano	1193
Correlation of High-Pressure Phase Equilibria in the Retrograde Region with Three Common Equations of State • Ralf Dohrn, Wolfgang Künstler and John M. Prausnitz	1200
Phase Equilibrium in the System Water-Hydrogen Sulphide: Hydrate-Forming Conditions • John J. Carroll and Alan E. Mather	1206
Contents Page from Chemical Engineering Research and Design	1212
Modified Shape Factors for Improved Viscosity Predictions Using Corresponding States • Wayne D. Monnery, Anil K. Mehrotra and William Y. Svrcek	1213
Reduction of Coal-Water Mixture Consistency with Soda Ash and Lime • Leon Y. Sadler, III and Kian G. Sim	1220

## Notes

A Deposition Velocity Correlation for Water Slurries • R. G. Gillies and C. A. Shook	1225
Characteristic Mixing Length in Bubble Columns • Y. Kawase and M. Tokunaga	1228
Book Review	1232

December 1991

## CSCHE/SCGCh 25th Anniversary Thematic Section: Transport Phenomena and Separation Processes

Introduction and Overview • Karl T. Chuang and Bruce D. Bowen	1233
Fluid Mechanics/Multiphase Flow	
Flow of Power Law Liquids Through Particle Assemblages at Intermediate Reynolds Numbers • A. K. Jaiswal, T. Sundararajan and R. P. Chhabra	1235
Transitional Packed Bed Flow in Standpipes • J.-Y. Zhang and V. Rudolph	1242
Flow Structure of the Dispersed Gasphase in Real Multiphase Chemical Reactors Investigated by a New Ultrasound-Doppler Technique • S. Bröring, J. Fischer, T. Korte, S. Sollinger and A. Lübbert	1247

Hydrodynamics in Down Flow Jet Loop Reactor • M. Velan and T. K. Ramanujam .....	1257
<b>Heat Transfer/Combined Heat and Mass Transfer</b>	
Drying in Capillary-Porous Cylindrical Media • M. C. Robbins and M. N. Özişik .....	1262
Marangoni and Buoyant Convection in a Cylindrical Cell Under Normal Gravity • J. A. Szymczyk .....	1271
Mixed Convection Heat Transfer Enhancement Through Latent Heat Transport in Vertical Parallel Plate Channel Flows • W.-M. Yan .....	1277
Performance of Two Heat Transfer Fouling Probes for Various Fluids • H. Müller-Steinhagen and C. A. Branch .....	1283
<b>Mass Transfer/Separation Processes</b>	
Solvent Extraction — The Challenges of a "Mature" Technology • M. H. I. Baird .....	1287
Homogeneous Azeotropic Distillation: Comparing Entrainers • L. Laroche, N. Bekiaris, H. W. Andersen and M. Morari .....	1302
Reactive Distillation of Pyridine Mixtures with an Organic Acid. I. Determination of the Reactive Distillation Equilibrium • Françoise Duprat and Georges Gau .....	1320
Reactive Distillation of Pyridine Mixtures with an Organic Acid. II. Parametric Sensitivity and Optimization of the Process • Françoise Duprat and George Gau .....	1327
Mass Transfer in Structured Corrugated Packing • P. A. Nawrocki, Z. P. Xu and K. T. Chuang .....	1336
Mass Transfer and Holdup in Gas-Liquid Cocurrent Flow Packed Beds Containing Water-Repellent Particles • Shigeo Goto, Keichiro Saikawa and P. D. Gaspillo .....	1344
Studies on Hydrophilic Polysulfone Ultrafiltration Membranes • A. Y. Tremblay, C. M. Tam, M. D. Guiver and M. M. Dal-Cin .....	1348
<b>Thermodynamics/Phase Equilibria</b>	
Experimental Determination of $P$ - $X$ , $L$ - $G$ Critical Locus and UCEP for Biphenyl- $\text{CO}_2$ Mixtures • D. Zhang, L. Wang, W. Sheng and B. C.-Y. Lu .....	1352
Equilibrium Solubility of $\text{H}_2\text{S}$ and $\text{CO}_2$ and Their Mixtures in a Mixed Solvent • Rosalynn J. MacGregor and Alan E. Mather .....	1357
Binary Liquid-Liquid Equilibria of Aniline-Paraffin and Furfural-Paraffin Systems • Subhash C. Sen, Soumen Maity, Kausik Ganguli, Kausik Goswami and P. Ray .....	1367
Phase Equilibria Calculations for Ill-defined Mixtures Using the PRSV Equation of State • E. L. Cheluget and J. H. Vera .....	1374
<b>Regular Papers</b>	
Settling Velocities of Particles in Bubbly Gas-Liquid Mixtures • D. Smuk, D. S. Scott, R. D. MacIntyre and I. G. Reilly .....	1382
Turbulent Circulation in Bubble Columns from Eddy Viscosity Distributions of Single-Phase Pipe Flow • Hean Luo and Hallvard F. Svendsen .....	1389
An Improved Correlation for Turbulent Drag Reduction in Dilute Polymer Solutions • Ron Darby and Suchat Pivsa-Art .....	1395
Effects of Stagnant and Dispersion Conductivities on Non-Darcian Forced Convection in Square Packed-Sphere Channels • F. C. Chou, P. Y. Chung and C. J. Cheng .....	1401
Computation and Optical Interferometric Determination of Concentration Profiles Near a Vertical Cathode • I. Nagatsugawa, D. L. Piron and J. Bures .....	1408
Thermal and Catalytic Cracking of $n$ -Heptane in Presence of $\text{CaO}$ , $\text{MgO}$ and Calcined Dolomites • Georgios Taralas, Vassilios Vassilators, Krister Sjöström and Jesus Delgado .....	1413
Table of Contents — 1991 .....	1420
Index of Authors — 1991 .....	1425
Keyword Index — 1991 .....	1431
Reviewers .....	1436
Contents Page from Chemical Engineering Research and Design .....	1430

